PROJECT facts

U.S. DEPARTMENT OF ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Gasification

09/2001

REGENERABLE DESULFURIZATION SORBENT

CONTACT

Ranjani Siriwardane
Senior Scientist
National Energy Technology Laboratory
(304) 285-4513
ranjani.siriwardane@netl.doe.gov

ADDRESS

National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
(304) 285-4469 fax

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
(412) 386-4604 fax

CUSTOMER SERVICE

(800) 553-7681

WEBSITE

www.netl.doe.gov

Removal of hydrogen sulfide (H_2S) from the coal gasification gas stream is important for environmental reasons and to protect system components from corrosion and deterioration. Development of a suitable regenerable sorbent for the removal of hydrogen sulfide from the gasification product gas stream has been a major barrier issue for gas stream cleanup at high temperatures. Major challenges for the development of a regenerable sorbent have included decrepitation, spalling, and loss of reactivity.

A regenerable desulfurization sorbent, developed by researchers at the U.S. Department of Energy's National Energy Technology Laboratory (NETL), has demonstrated very high attrition resistance and stable reactivity under numerous testing regimes in both simulated and actual fuel gas conditions. This sorbent, identified as RVS-1, is suitable for applications in a wide range of temperatures (260-600 °C or 500-1100 °F). This sorbent is commercially available from Sud Chemie (formerly United Catalysts Inc.). The moving/fixed-bed version of this sorbent exceeded all stringent performance criteria required for use in the Tampa Electric Company Clean Coal Technology (TECO/CCT) electric power generation plant. The sorbent has a high sulfur capacity of 17 to 20 wt percent demonstrated during multiple cycle tests while maintaining the H_2S level below 5 parts per million. Mechanical strength and attrition resistance of the sorbent remained stable or improved during multiple cycle tests. In addition, the sorbent has shown excellent performance during a 20-cycle bench scale test with simulated KRW coal gas and during a test at the General Electric moving bed reactor (pilot scale) with real coal gas similar to TECO gas.

NETL

Regenerable Desulfurization Sorbent

RVS-1 proves to be a very economical and efficient desulfurization sorbent for the DoD's fuel cell system to power marine vessels using distillate reformate gas as fuel

Concentration of H_2S in the gas stream had a major effect on the sulfur capacity of the sorbent at both low pressures and low temperatures. Even at low temperature (260 °C or 500 °F), it was possible to achieve a sulfur loading of 17 wt percent, indicating that the sorbent is suitable for applications over a wide range of temperatures. The sorbent is suitable for sulfur removal from gas streams with both low and high reducing power. The sorbent can be easily regenerated at 482 °C (900 °F) with oxygen. Presence of steam during regeneration does not affect the sorbent performance. In addition to H_2S, the sorbent is also capable of absorbing other sulfur compounds, such as dimethyl sulfide and carbonyl sulfide.

It was also possible to achieve sulfur removal efficiencies in the part per billion range with the modified RVS1 sorbent at 316 °C (600 °F). A twenty-cycle test conducted at Research Triangle Institute with simulated coal gas indicated that the sorbent maintained the part per billion level sulfur removal efficiency during all 20 sulfidations.

This sorbent can also be utilized for desulfurization applications for non-coal derived fuel gas streams. McDermott Technology, Inc. (MTI), a contractor under the Department of Defense (DOD) Ship Service Fuel Cell Program, tested the RVS-1 sorbent to remove sulfur from naval distillate reformate gas. The goal of the DOD program is to develop a fuel cell system to power marine vessels using the distillate reformate gas as the fuel. Because of the sensitivity of fuel cells to sulfur impurities in the feed gas, a very efficient desulfurization sorbent is needed for this system. Regenerable sorbents are not currently being used in this program due to unavailability of a suitable sorbent. The RVS-1 sorbent showed excellent performance during multi-cycle bench scale tests with simulated conditions suitable for the MTI system, conducted by Research Triangle Institute. As a result, MTI has selected the RVS-1 sorbent for their program and successfully conducted a 100 hr test (10 cycles) for sulfur removal from reformed diesel fuel utilized in the 2.5 kilowatt fuel cell demonstration project for ship board applications (sulfidation at 440 °C or 825 °F and regeneration with 2.5 percent oxygen). Utilization of RVS-1 sorbent should reduce the cost substantially and also minimize the required weight and volume of the desulfurization process in marine vessels.

The sorbent development work received R&D 100 award in year 2000 which is given by R&D Magazine for the 100 most significant technology developments in year 2000.